# THE ABORTIVE SPIKE OF BOTRYCHIUM

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 164

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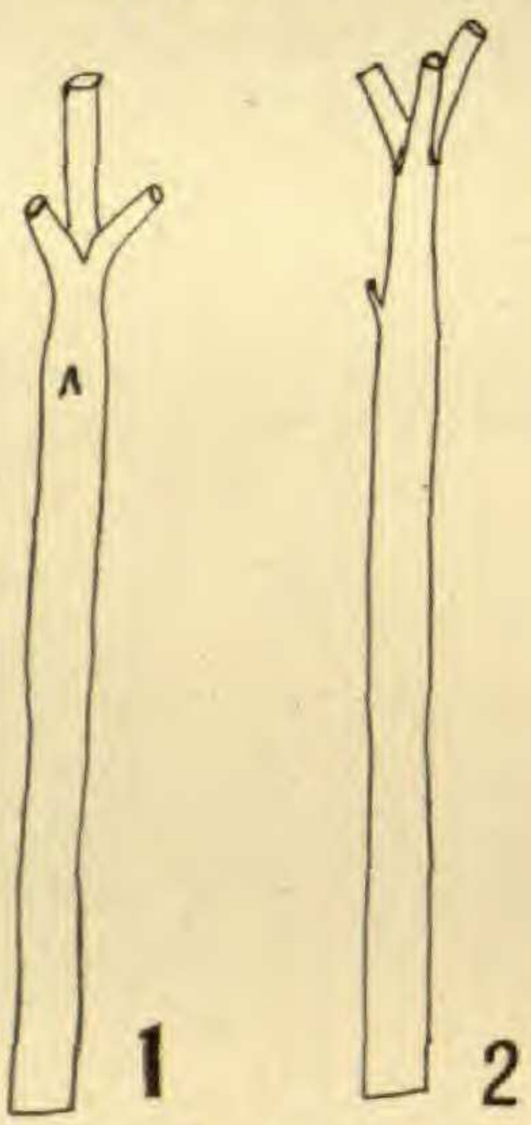
(WITH TWENTY-ONE FIGURES)

Interest in the study of the vascular anatomy of the Ophioglossaceae has increased since CHRYSLER'S work[1] on the nature of the fertile spike appeared in 1910. He made the vascular supply of the leaf the basis for concluding that the fertile spike represents two fused basal pinnae. The nature of the vascular supply of the abortive spike has so far received no special attention.

This investigation was undertaken to determine the origin and nature of the vascular supply of the abortive spike, and to compare it with that of the sterile pinnae and the fertile spike. CHRYSLER found that the series of changes undergone in the origin of the strands to the sterile pinnae were precisely the same as those for the fertile spike.

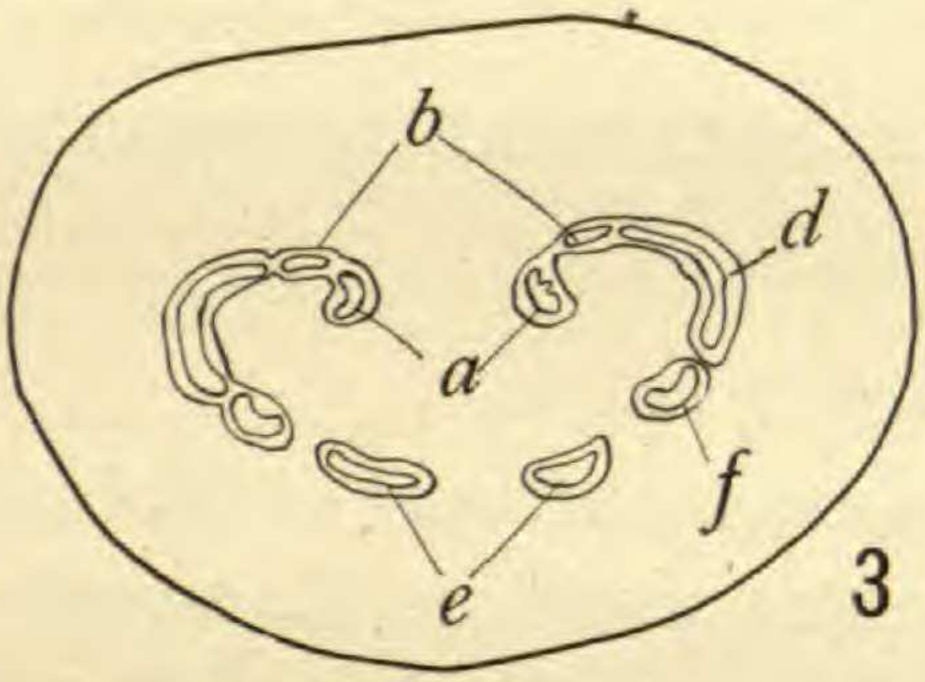
The material studied was *Botrychium virginianum*, the species from which CHRYSLER made his figures illustrating the origin of the strands to the fertile spike and sterile pinnae. The abortive spike is of very common occurrence in this species. It appears on the adaxial side of the petiole as a minute structure about 2 cm. below the first pair of sterile pinnae (figs. 1, 2). The fertile spike, however, always comes off from the main axis slightly below the first pair of pinnae. The elongation of the petiole after the abortive spike separates from the axis leaves it some distance below the first pair of pinnae.




FIGS. 1, 2.—Fig. 1, adaxial view of the petiole, with the abortive spike and first pair of pinnae cut off; one-half natural size; fig. 2, lateral view of same.

[1] CHRYSLER, M. A., The nature of the fertile spike in Ophioglossaceae. Ann. Botany 24:1–18. *figs. 1–16. pls. 1, 2.* 1910.

Serial sections were made throughout the petiole from about 8 cm. below the abortive spike to the place where the first pair of sterile pinnae appear. Figs. 3–10 show the changes undergone in



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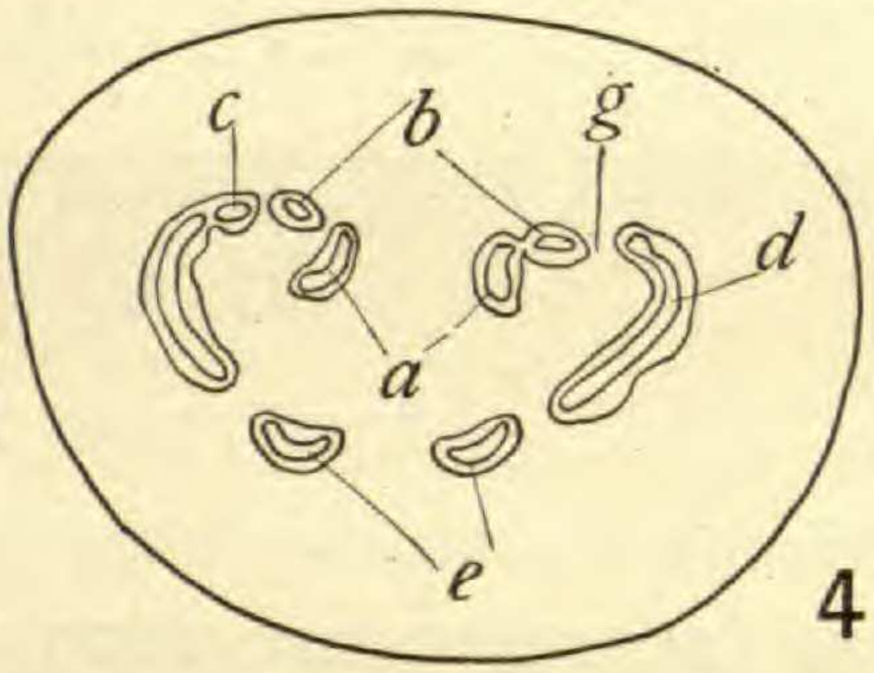

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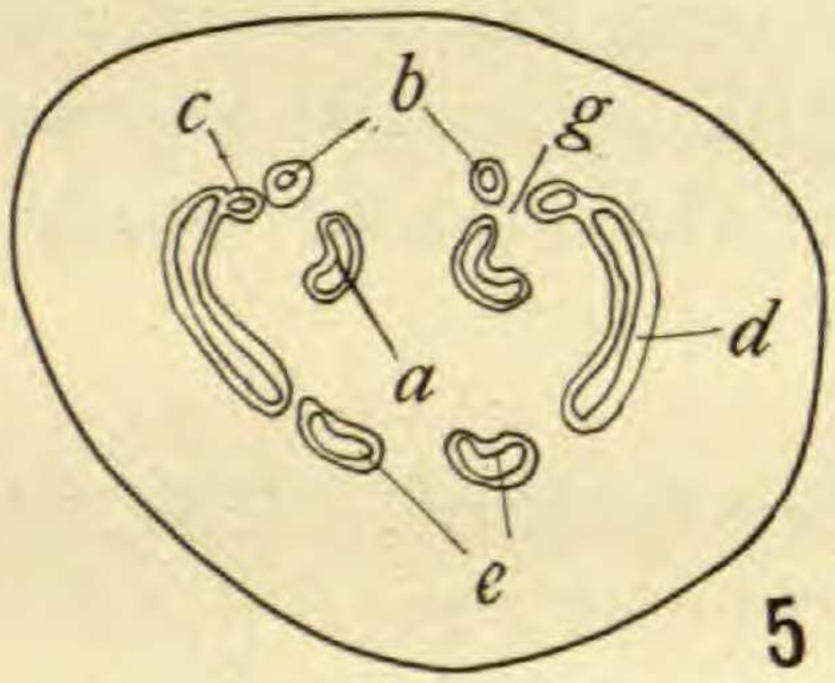

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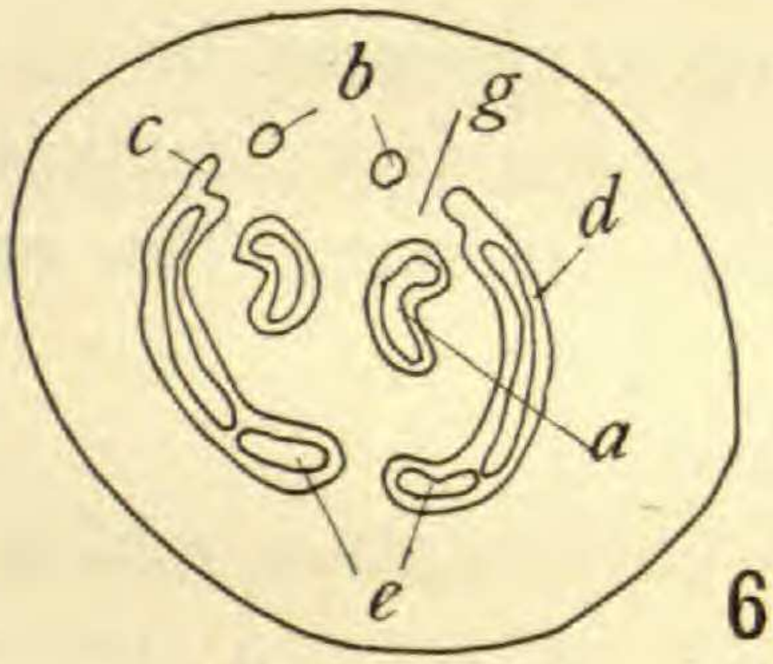

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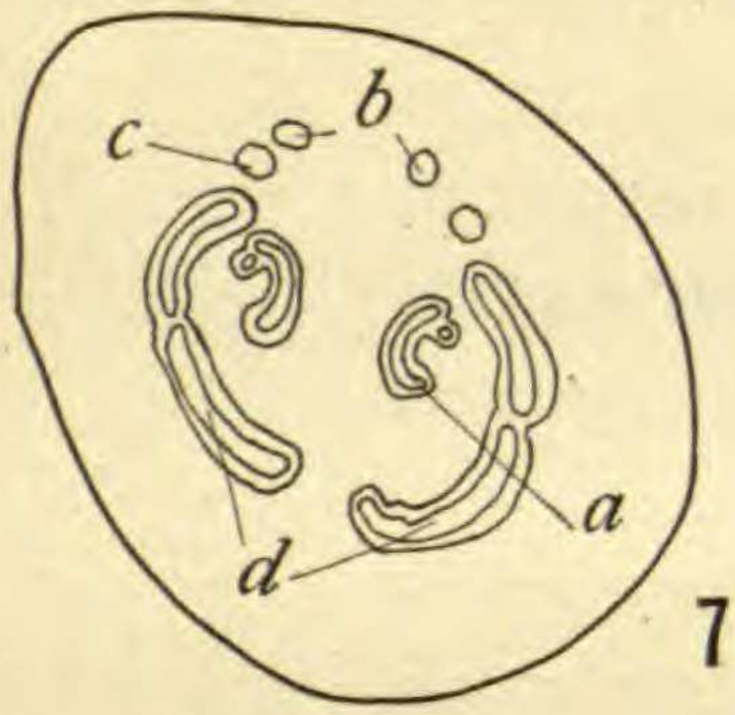

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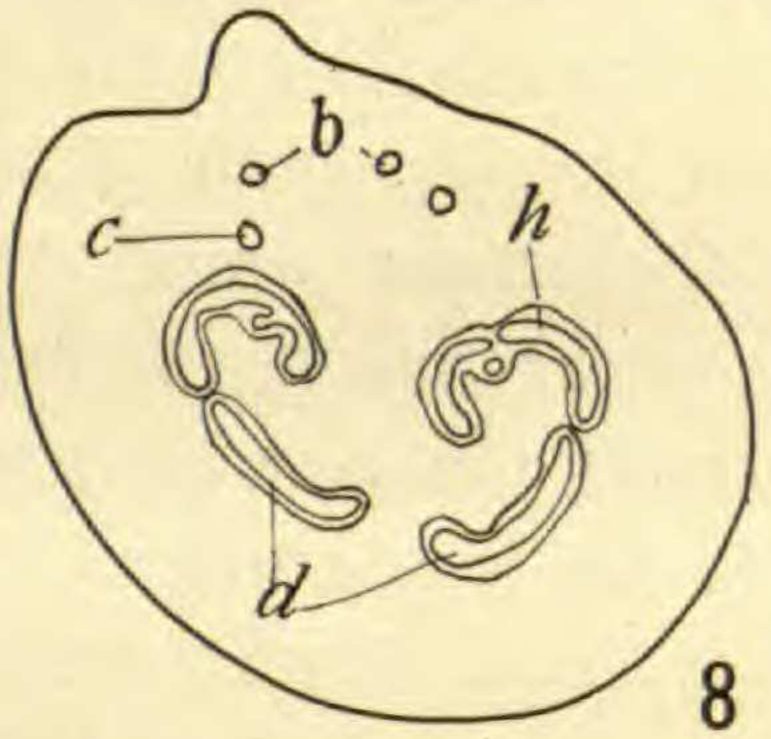

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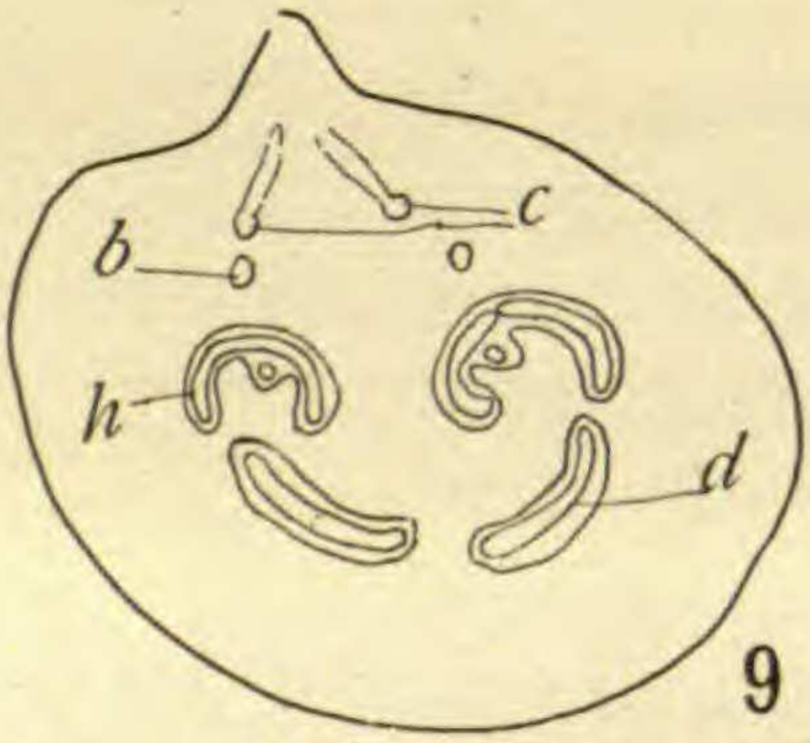

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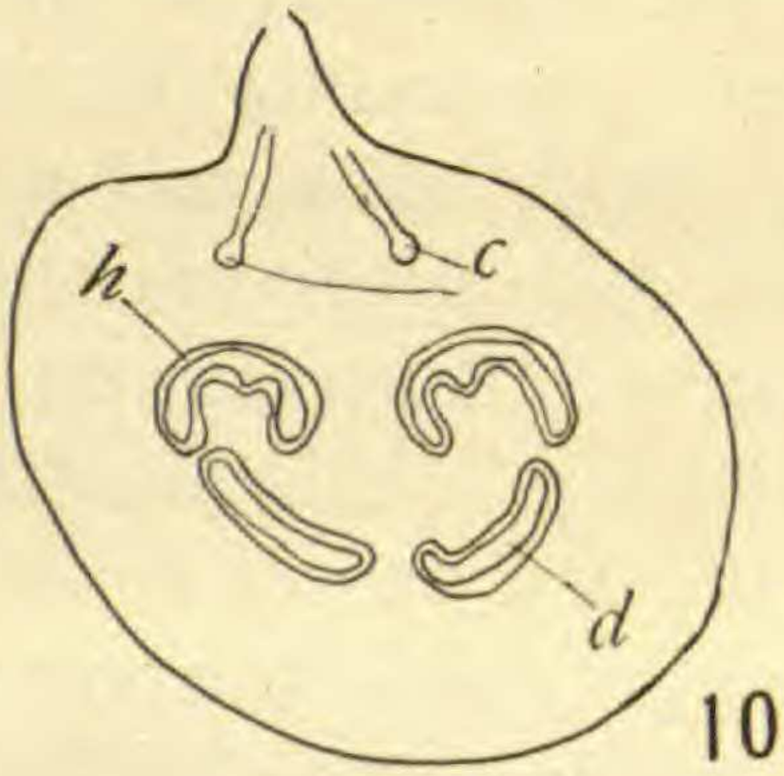

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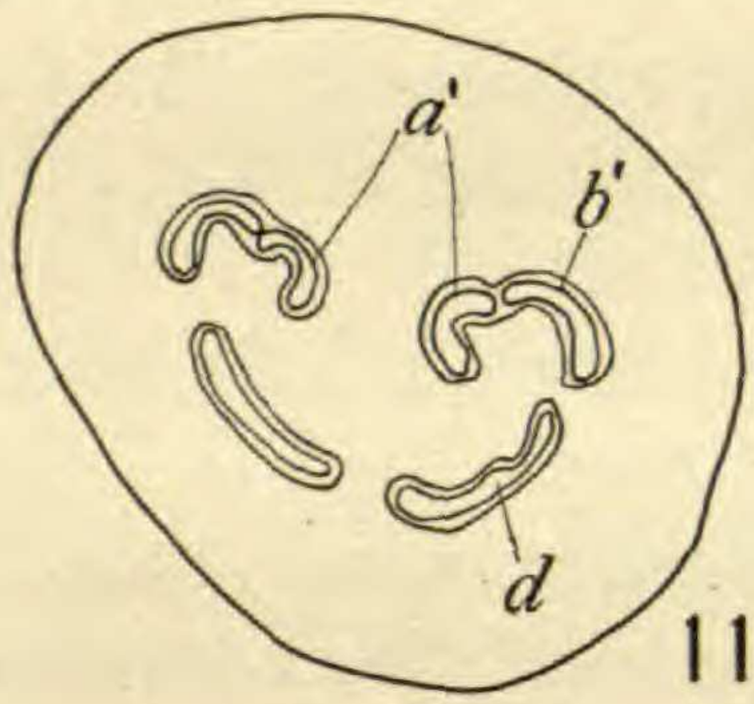
FIGS. 3–10.—Diagrams illustrating the origin of the vascular strands to the abortive spike, made with the aid of an Abbé camera lucida and reduced one-half in reproduction: distances below abortive spike as follows: fig. 3, 7.6 cm.; fig. 4, 5.3 cm.; fig. 5, 2.1 cm.; fig. 6, 4 mm.; figs. 7 and 8, about 1 mm.; figs. 9 and 10, opposite the abortive spike; adaxial side of petiole placed upward; ×15.

the vascular strands relative to the supply of the abortive spike. The vascular strands are all of the concentric type throughout the aerial part. About 8 cm. below the abortive spike the leaf trace consists of three pairs of strands (fig. 3, *d*, *e*, *f*), one large lateral pair (fig. 3, *d*), and two pairs on the abaxial side (fig. 3, *e*, *f*). One of the pairs (fig. 3, *f*) soon unites with the abaxial margin of the lateral strands (fig. 4). The second pair (fig. 3, *e*) remains free to within 1 cm. of the abortive spike, where it also unites with the abaxial margins of the lateral strands (fig. 6). The vascular strands of the abortive spike originate about 8 cm. below the point where the spike leaves the petiole. The adaxial arms of the lateral strands become hooked (fig. 3) and soon a curved strand (figs. 3–7, *a*) is cut off so that a gap is left in the sides of the leaf traces (figs. 4–6, *g*). From each side of these gaps a small strand breaks off to supply the abortive spike (figs. 4–8, *b*, *c*). The outline of these strands appears below the gap, so that they really originate from its base (fig. 3, *b*).

There are then four strands, that is two on each side, that supply the abortive spike. They adhere to the sides of the gap for some distance, but finally break off, one 5 cm. (figs. 4, 5, *b*), the other about 2 cm. (fig. 7, *c*) below the abortive spike. From this point they remain as separate strands running along the gap and finally enter the abortive spike (figs. 9, 10, *b*, *c*). The gaps in the lateral leaf traces close about 4 mm. below the abortive spike (fig. 8). At about this point the two lateral traces (fig. 8, *d*) each divide into two equal strands. The adaxial strands thus formed are hooked (figs. 8–10, *h*). These adaxial hooked strands each divide into two equal parts (fig. 12, $A'$, $b'$) of which the outer pair ($b'$) diverge to pass out to the pinnae (figs. 11–15, $b'$). Another pair of strands (figs. 13, 14, $c'$) arise from the adaxial margin of the lateral strand (figs. 13, 14, *d*), so that each pinna has two strands. Where these strands ($c'$) leave the leaf trace the gap becomes closed, strand $a'$ uniting with strand *d*. The leaf trace above the origin of the first pair of pinnae consists of two lateral strands (fig. 15, *d*). By a study of figs. 3–15 it will be seen that the same series of changes occurs in the origin of the vascular supply of the sterile pinnae as for the abortive spike.

In some of the leaves examined the vascular supply of the abortive spike consisted of a single pair of strands, that is, one from each side, but in such cases there were two pairs of strands for

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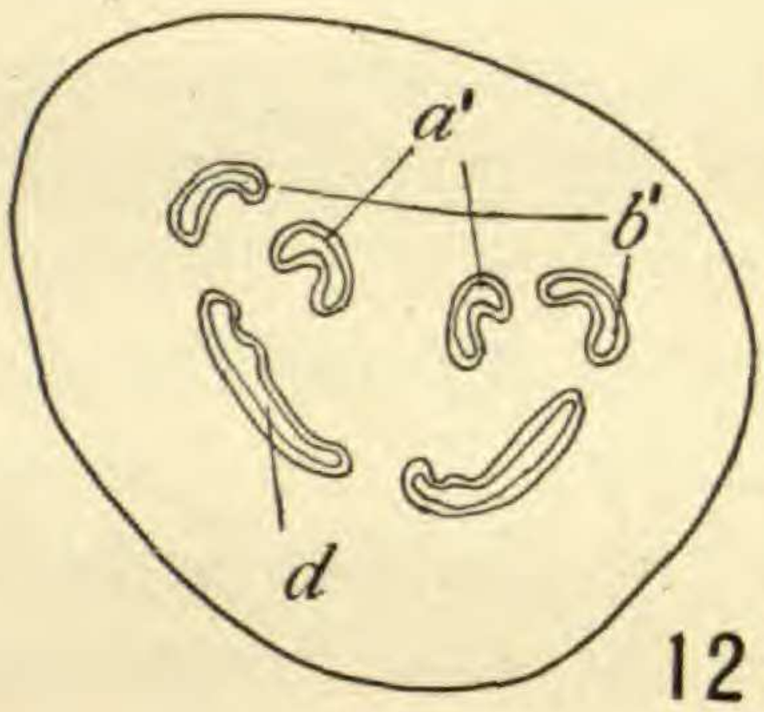


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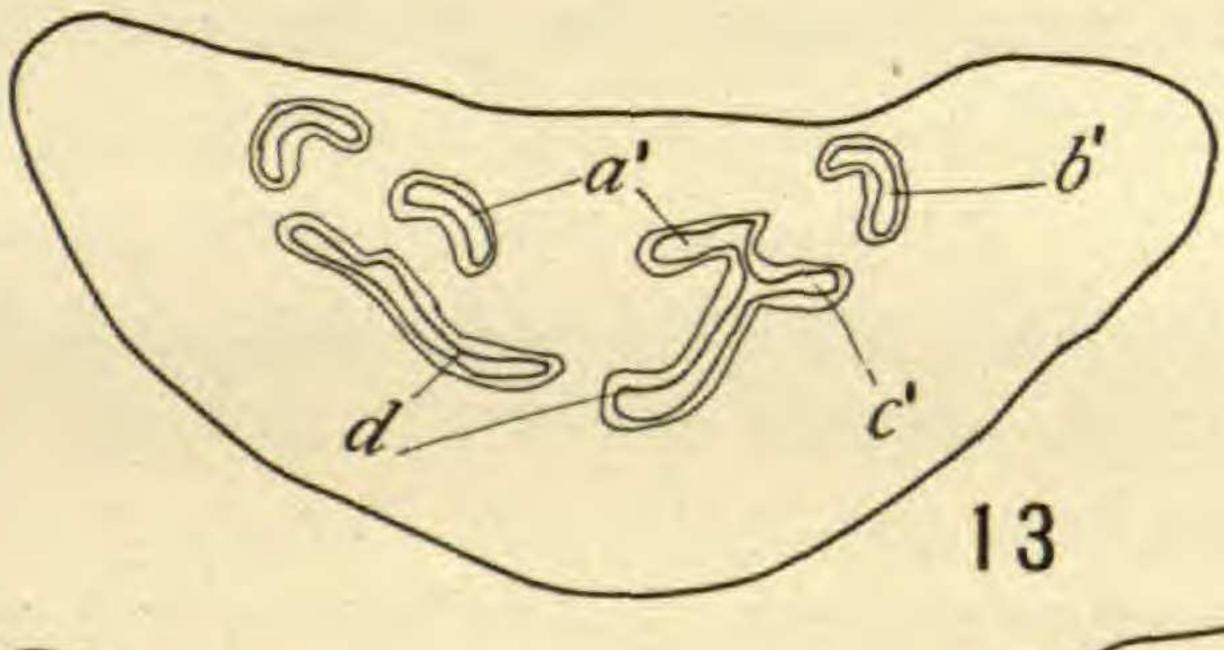


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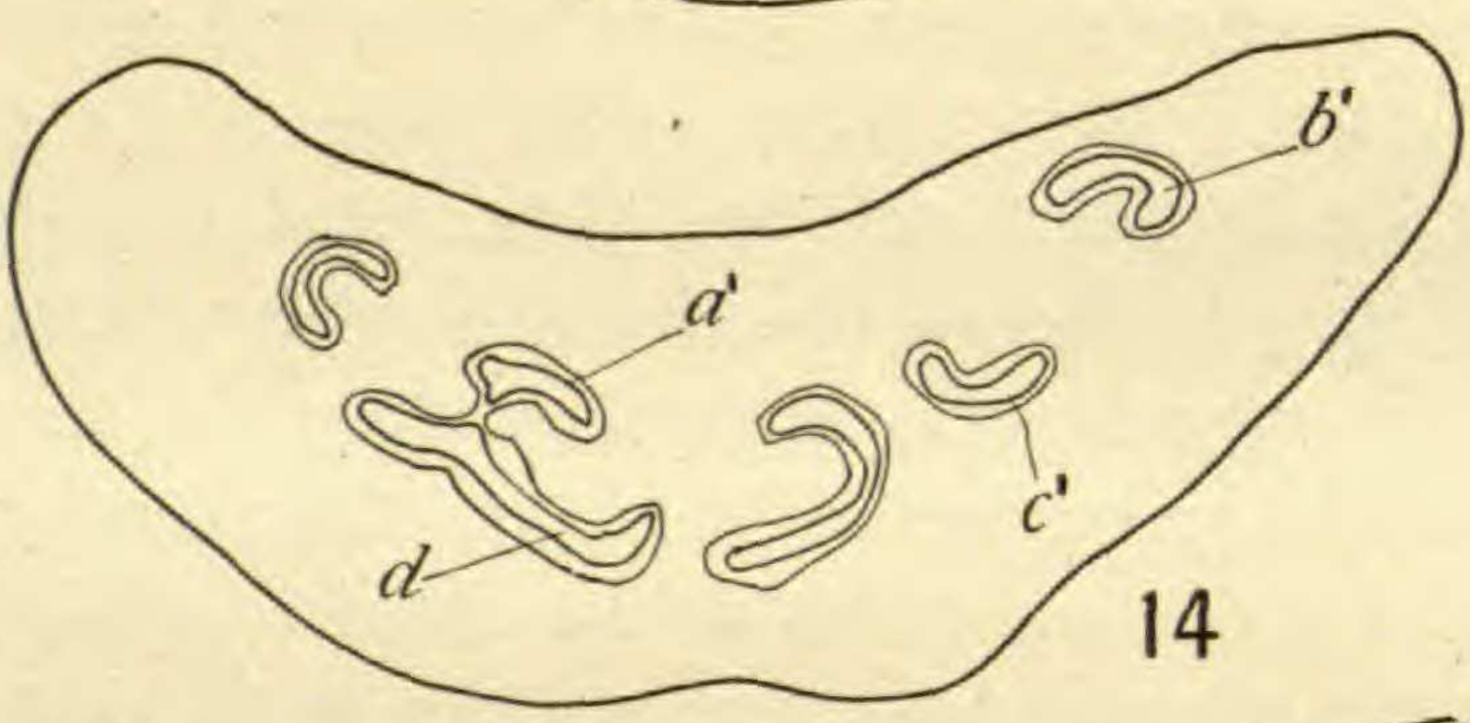


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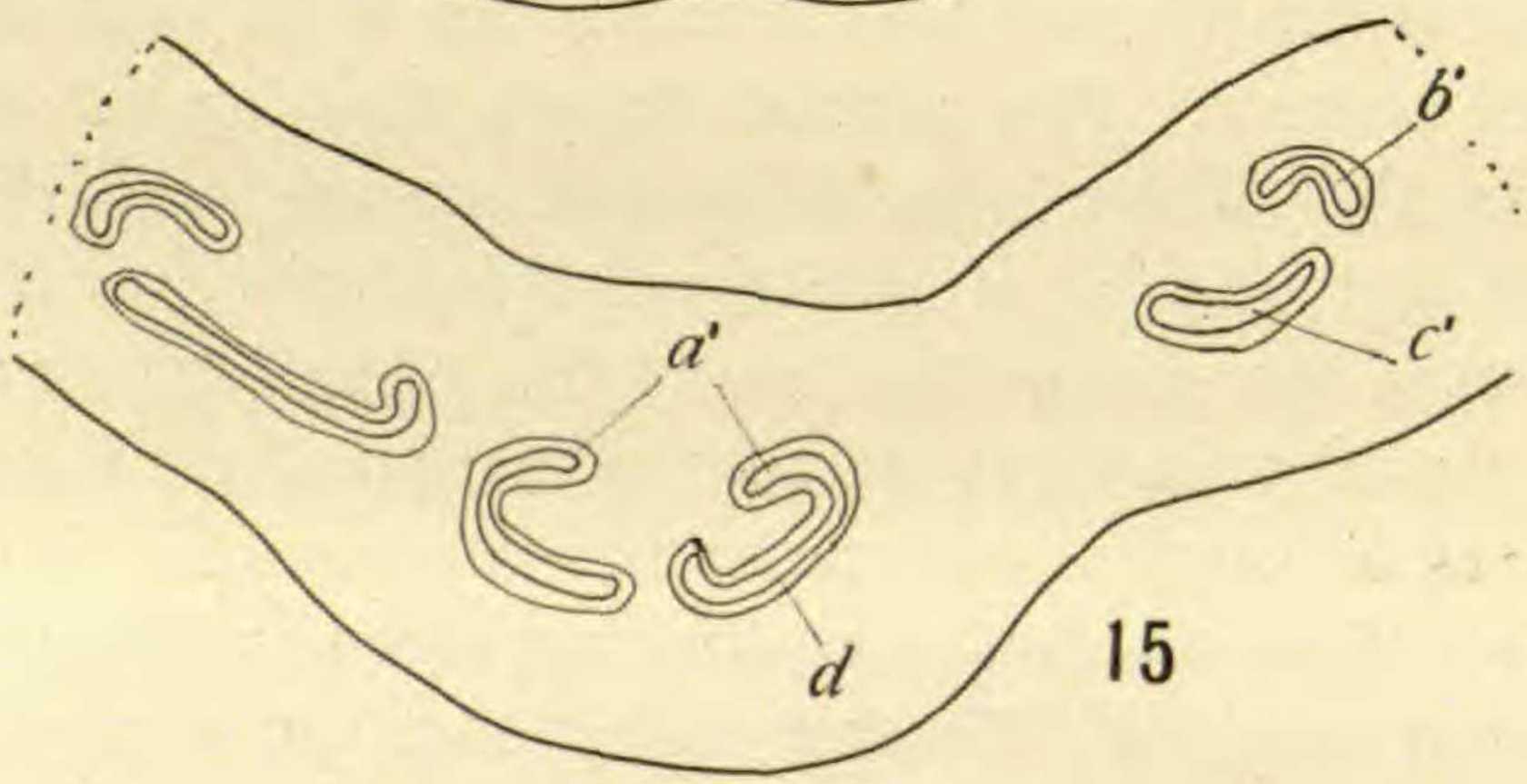


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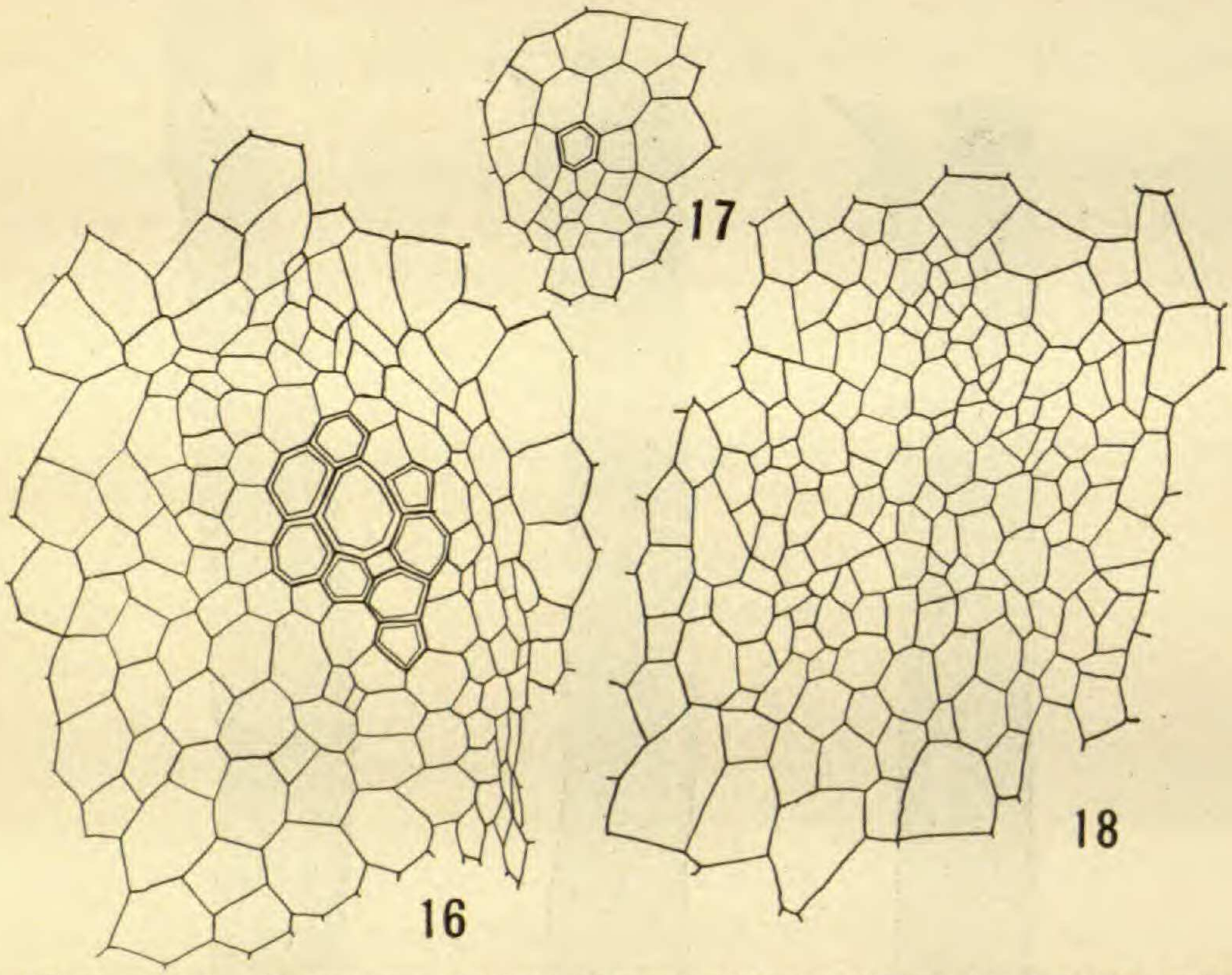
FIGS. 11–15.—Diagrams following the series shown in figs. 3–10, illustrating the origin of strands which supply the first pair of sterile pinnae; fig. 11, 5 mm. above abortive spike; fig. 12, 1 cm. above it; figs. 13–15, opposite the point where the pinnae diverge.

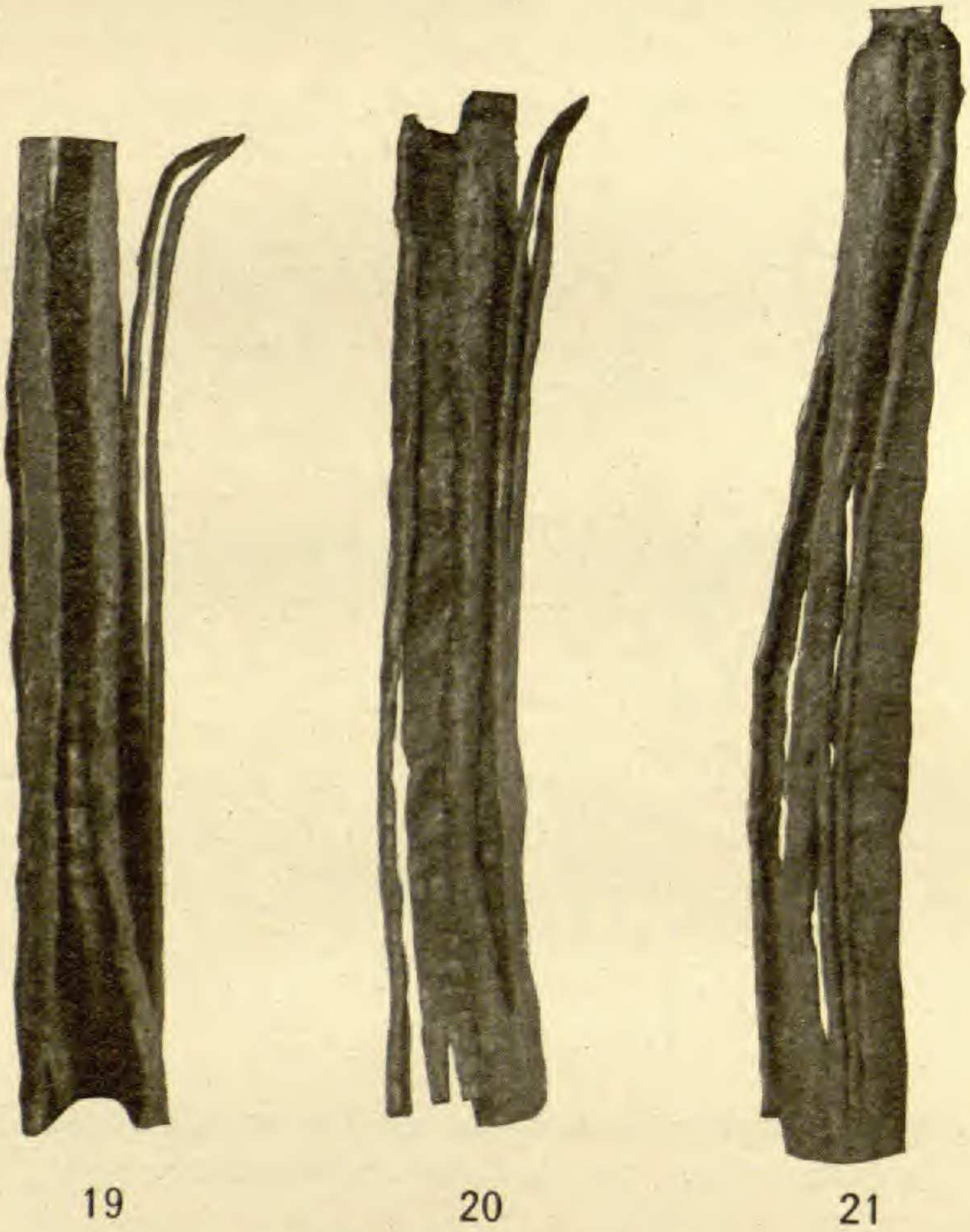
each pair of sterile pinnae. As shown in figs. 16–18, the strands of the abortive spike may have well developed primary xylem in the lower stretches (fig. 16), but farther up the xylem gradually fails to appear (fig. 17), and before they turn outward no xylem is formed. Here the strands are distinguished by their narrow elongated cells. In other cases no traces of xylem could be found throughout strands of the abortive spike.




FIGS. 16–18.—Transverse sections through the strands of the abortive spike, showing development of xylem; fig. 16, 12 mm. below abortive spike; fig. 17, 4 mm.; fig. 18, 3 mm.; ×210.

If figs. 3–15 are compared with CHRYSLER'S figures showing the origin of the strands to the fertile spike, it becomes evident that the changes are essentially the same. A few exceptions may be noted. The first strand (*a* and *a'*) which breaks off on the adaxial side does not unite with the inner face of the large strand as it does in the case of the fertile spike. The gaps left by the strands to the abortive spike are much more evident. These are shown in the photographs of models in figs. 19–21. These models show only one-half of the vascular supply. In fig. 19, which shows the inner

face of the lateral strand, the two strands to the abortive spike are very evident, with the long gap behind them. The gap is seen even better in fig. 20, which shows also part of the adaxial face. Fig. 21 shows the adaxial face of the model with the two narrow strands to the abortive spike obscuring the gap. Four such strands are present in the petiole, but the model shows only one-half of the



19 20 21

FIGS. 19–21.—Photographs of model of the leaf traces on one side of the petiole in region where strands to abortive spike originate; fig. 21, adaxial face.

vascular supply. The pinnae of the leaves bearing the fertile spike usually have only one vascular strand, while those that accompany the abortive spike have two in all cases examined.

The breaking up of the leaf traces into curved rows of bundles below the origin of the strands to the abortive spike does not occur as regularly in the petioles with the fertile spike. This condition is described by CHRYSLER for *Ophioglossum* and *Helminthostachys*,

where the vascular supply of the fertile spike is derived from curved rows of strands.

## Summary and conclusions

1. The leaf trace of the petiole bearing the abortive spike consists of several bundles instead of two bundles as usually found in the petiole bearing the fertile spike.

2. The vascular supply of the abortive spike consists of two or four strands arising from the edges or the base of the gap in the leaf trace.

3. The pair of sterile pinnae following the abortive spike are supplied by two pairs of strands originating in the same way as those for the abortive spike.

4. Xylem may or may not appear in the strands to the abortive spike, but it never appears throughout the entire strand.

5. The difference between the origin of the strands to the abortive spike from those to the fertile spike is very slight.

6. The nature of the vascular supply of the abortive spike supports CHRYSLER'S contention that it represents two fused basal pinnae.

This work was undertaken at the suggestion of Professor COULTER and under the direction of Dr. CHAMBERLAIN, and I wish to express my appreciation for their valuable suggestions and criticisms. I also wish to express my thanks to Dr. M. A. CHRYSLER for valuable criticism.

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